ATTACHMENT A – Regulatory Agencies Detailed Technical Comments

Comment 1

Section 2.1.1, Site Description, Page 2-1

Lines 4-11

- The Scope of work should clearly define the boundaries of the site, study areas and modeling domain. The yellow line on Figure 1, page 2-3 indicates the site boundaries. The Regulatory Agencies assume the study area is the entire area as presented in Fig. 1. The Navy should clarify the study area boundaries and use these definitions throughout the document.

Comment 2

Lines 25-29

- Similar to the comment the Regulatory Agencies made on the Monitoring Well Installation Work Plan ("MWIWP"), we believe it is incorrect to characterize the Red Hill Navy Supply Well as downgradient from the tanks. The terms "down gradient" and "cross gradient" are used throughout this SOW/WP, however the regulatory agencies believe this SOW/WP needs to reflect the uncertainty about the actual groundwater flow paths in the study area.

  Since the actual downgradient direction in the vicinity of Red Hill has not been adequately defined, this sentence should acknowledge that uncertainty by stating the importance of this and other investigations to characterize groundwater flow patterns beneath the footprint of the facility. It would be more accurate to state, "the assumed down gradient direction" or similar due to lack of certainty of local groundwater gradients beneath the facility.

  A consistent distance between the well 2254-01 and the USTs needs to be used. This issue was also discussed during the MWIWP review and changes similar to those agreed upon in finalizing the MWIWP are required in this SOW/WP. It seems most appropriate to use the distance from the east end of the infiltration gallery to UST 1 (approximately 1,500 ft).

Comment 3

Section 2.1.2, Site History, Page 2-2

Lines 18-22

- The construction sequence of tanks is not described accurately. Upper domes were constructed first, cavity for tank barrel and bottom blasted and excavated and then barrel and bottom of tank were constructed.

Comment 4

Lines 36-38

- The statement, "Test results from Navy Supply Well 2254-01 and the BWS wells' samples indicated that no petroleum constituents had reached the groundwater in the months following the release," incorrectly paraphrases the Red Hill Storage Facility Task Force Report from 2014. That report indicated that no petroleum compounds were detected in drinking water wells. It did not state that petroleum constituents were not detected in the groundwater. Elevated TPH concentrations detected at RHMW02 after the January 2014 tank 5 release were almost certainly related to that release, indicating that petroleum constituents did reach the groundwater.

Comment 6

Page 2-9

Lines 15-17

- This paragraph states that "major hydrogeologic barriers" are present near the Oily Waste Disposal Facility that, in combination with other factors, resulted in insignificant contaminant transport from the OWDF to the basal aquifer. The Navy should either describe these barriers in more detail or provide a reference. The presence of hydrogeologic barriers are important in the investigation of contaminant transport in this SOW. If information on their presence was considered in the OWDF investigation, then it may be applicable to the Red Hill investigation.

Comment 7

Section 2.3.1.3, RHSF Technical Report, Page 2-11

Lines 14-17

- This section states that the Fate and Transport (F&T) Modeling conducted in 2007 led the Navy to conclude that valley fills in the North Halawa Valley are effective barriers to particle migration of water beneath the facility. More precisely the F&T Modeling concluded it was the valley fill in North Halawa Valley that may pose a barrier to groundwater flow. Yet, while discussing monitoring locations as part of our review of the MWIWP (July 2016), the Navy seems focused on demonstrating that the South Halawa Valley fill is the more relevant barrier to groundwater flow and resisted suggestions from the Regulatory Agencies to investigate the extent and nature of the North Halawa Valley fill. This paragraph seems to support the Regulatory Agencies view that the North Halawa Valley should be further investigated as part of this work plan.

Comment 8

Section 2.3.1.5, Type 1 Letter Report, Page 2-12

Lines 34-40

- This paragraphs states that a groundwater gradient of 0.00022 ft/ft was reported toward well 2254-01, while a gradient of 0.00028 ft/ft was reported to the northwest. This is not consistent with numerous statements throughout the SOW/WP that well 2254-01 is downgradient from the USTs while the Halawa Shaft is cross gradient from the USTs as it appears the greatest gradient is to the northwest. The groundwater flow direction (i.e. effective gradient) is currently unresolved and one of the purposes of the proposed work is to remove the uncertainty.

Comment 9

Section 2.3.2.2, Groundwater Monitoring Program, Page 2-14

Overall comment on section 2.3.2.2

Rather than simply providing the data in a narrative form, which makes it more difficult to visualize data trends, this section should include figures for each monitoring well location that plot the data over time for the major contaminants of concern.

Comment 10

Lines 36-39

- This description of the TPH-d trends at RHMW01 fails to note the generally increasing trend in concentrations since January 2015. This paragraph should be amended to note the increasing trend of TPH-d concentrations since that date. As currently written, the paragraph implies that TPH-d concentrations continue to decrease since 2005 and that statement is not supported by the data.

Comment 11

Page 2-15,

Lines 20-21

- The contention that the very low COPC (primarily TPH-d) concentrations detected at RHMW05 suggest that contamination is not migrating downgradient is really an overstatement of the facts as we currently understand them. Since the groundwater flow patterns are not resolved, the direction of contaminant migration is likewise unresolved.

Comment 12

Section 2.3.2.2, Groundwater Monitoring Program, Page 2-16

Lines 11-16

- This description of the COPC detections at RHMW04 fails to note the generally increasing trend in TPH-d since January 2015. The Regulatory Agencies wish to note that the location of RHMW04 and the fact that TPH-d has been detected implies that there is some component of groundwater flow that moves in the general direction of the Halawa municipal pumping centers.

Comment 13

Section 3.5.2, Site Geology, Page 3-7

Line 1

- This sentence describes the lava beds as "nearly horizontal". However, there is a dip to the lava flows and the direction of dip is important to understand how fuel product may move in the vadose zone. The Regulatory Agencies believe an acknowledgement of the potential for these beds to dip is important. This paragraph should include a sentence stating that characterizing the strike and dip of the lava flows is important for understanding any product migration in the vadose zone outside of the concrete cocoon of the tanks and will be conducted as part of the overall hydrologic investigation.

Comment 14

Section 3.6.1, Regional Hydrogeology, Page 3-7

Lines 20-31

- These two paragraph state that there are two principle aquifer types in Hawaii. It fails to mention high level dike confined water that is an important aquifer type and supplies municipal drinking water in many locations on Oahu.

Comment 15

Section 3.6.2, Site Hydrogeology, Page 3-8

Lines 4-7

- This paragraph incorrectly ranks the hierarchy of the State of Hawaii Aquifer designation in the eastern portion of the Red Hill Facility. The eastern portion of the Red Hill Facility is in the Moanalua System of the Honolulu Aquifer Sector (i.e. the Moanalua Aquifer is subordinate to the Honolulu Aquifer). It would be more accurate to state the facility overlies the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector and the

Moanalua Aquifer System of the Honolulu Aquifer Sector. The two aquifers almost equally bisect the Red Hill Facility.

Comment 16

Lines 17-20

- As mentioned in comment 5 above, the Regulatory Agencies believe it is important for this work plan to include further investigation of the extent and nature of the North Halawa Valley fill. This paragraph states that the North Halawa Valley fill is likely acting as a barrier to flow between the Moanalua and Waimalu aquifers.

Comment 17

Lines 26-31

- See Comment 1 above

Comment 18

Page 3-13, Figure 6, Geological Cross Section (Transverse)

- As we stated in our comments to the MWIWP, the Navy provides no basis for the extent of the Valley Fill and Saprolite areas as depicted in Figure 6. The Navy needs to provide supporting documentation or references to support the characterization of the valley fill or clearly indicate that the extent of the valley fill depicted on the figure is speculative and not supported by geologic evidence.

Comment 19

- Figure 6 should be updated to show the new location of proposed well RHMW11 as well as an indicator to show the additional depth of RHMW11 in the event that bedrock is not encountered at the target depth.

Comment 20

- As stated in our comments on the MWIWP, Figure 6 incorrectly shows the Halawa Shaft terminating within the valley fill. The Halawa Shaft is actually a horizontal infiltration gallery in the basalt northwest of the valley fill. The Halawa Shaft is bored into the wall of North Halawa Valley so the depiction of a vertical well located in the center of the valley is inaccurate.

Comment 21

- Remove the word "sporadic" from Note 1 of Figure 3. Note 1 should be revised to, "Existing well logs show a complex subsurface comprised of alternating pahoehoe and a'a lava flow with clinker zones, fractures, and voids."

Comment 22

Page 3-15, Figure 7, Longitudinal Cross Section

- Delete the word "Geological" from the title of this figure since no geologic features are depicted in this figure. Also the year associated with symbol for RHMW2254-01 should be 2005 not 2009.

Comment 23

Section 3.6.2.2, Groundwater Levels and Hydraulic Gradients, Page 3-17

- This section should include an introductory discussion of groundwater flow gradients and the potential impacts of measurement or survey error, pumping effects, and seasonal and tidal effects on gradient.

Comment 24

Lines 2-24

- The description of the hydraulic flow characteristics of the various rock types would be more appropriate in Section 3.6.1, Regional Hydrogeology.

Comment 26

Lines 36-43

- It should be noted, and as described by D. Oki of the USGS, that USGS/HBWS pumping test done in May 2015 did see a response on the Red Hill side of the North and South Halawa Valleys to changes in pumping stress at the Halawa Shaft. A careful evaluation of the 2006 aquifer test responses also indicate a possible response across the Halawa Valley Fills.

Section 3.7, Geological Conceptual Site Model

Comment 27

- The Navy should follow the DOH Technical Guidance Manual, Section 3.3 guidelines for the Conceptual Site Model (CSM) development. The Navy should include the representative site environmental conditions with respect to environmental hazards, such as site conditions, extent of contamination, contaminant pathways and potential receptors, then present the CSM specific to Red Hill. For the CSM the Navy shall use tank construction information, available boring logs, barrel logs, pump tests and historical analytical data. The CSM should include a discussion of potential contaminant pathways including, but not limited to, a release from Tank 5 that flows laterally out of the concrete surrounding the tanks, and a release from tank that flows down within the concrete cocoon.

Comment 28

Section 3.7.4, Red Hill Vadose Zone, Page 3-28

- This section repeats general geology information that was presented earlier in Section 3. Much of the information presented is not site-specific to Red Hill. Perhaps a review of Wentworth (1942), MacDonald (1941), and Stearns (1941) may provide valuable Red Hill specific insight. Section 3 does not meet the requirement for developing a ~~thoroghthorough~~thorough Conceptual Site Model (CSM) as required by the AOC.

Comment 29

Lines 14-22

- The contention that RHMW07 is not in hydraulic communication with the other Red Hill wells is not borne out by the USGS/HBWS pumping test. The water level in RHMW07 did vary in response to pumping stresses as did other wells located at the Facility. It is true that the connection must be through some hydraulic barrier to account for the abrupt change in water between RHMW07 and nearby wells. The Navy postulates that the barrier could be a dike and this is certainly within the realm of possibility. These dikes, if they exist, will also greatly influence the groundwater flow direction in a way that is not predictable from water level observations alone. Also, the discussion in these lines do not seem to fit in a description of the vadose zone.

Comment 30

- The SOW/WP proposes that the Red Hill area may be a dike complex. This contention comes with serious implications. First is that the assumption the geology can be modeled as an Equivalent Porous Medium becomes invalid since the scale of dikes are 100s to 1,000s of meters. These heterogeneities will not be averaged out over the scale of concern that is also 100s to 1000s of meters. These statements also fail to show how the density of dikes if present could meet the definition of a dike complex that is more than 100 dikes per mile (Takasaki and Mink, 1984). There are no identified dikes in the Red Hill area, yet there are deeply incised valleys that should reveal a dike complex if one was located there. However, the Regulatory Agencies do acknowledge that the anomalous water levels in RHMW07 and Moanalua DH43 well as well as the late stage eruptions ~~Sa~~makai of the facility indicate some dikes and other intrusives could be present.

Comment 31

Section 3.7.4, Red Hill Vadose Zone, Page 3-29

Lines 8-12

- It is true that numerical modeling of NAPL transport in the vadose zone would be fraught with such uncertainty as to make this effort meaningless. However, a vadose zone assessment is critical and ample data exists to significantly increase our understanding of the fate and transport of fugitive fuel as it moves through the vadose zone. Knowledge of likely migration paths and amount of NAPL residual held in the vadose zone are important parameters for evaluating risk to the groundwater and to drinking water.

  Much characterization of the vadose zone can be done without intrusive drilling. A vadose zone assessment could include many important evaluations such as:

  - Defining the strike and dip of the lava flows using tank excavation and well geologic log;
  - Vertical fluid transport velocities using correlations between precipitation, and water level and soil vapor data; and
  - A statistical interpretation of the stratigraphy to evaluate relative abundances and thickness of the major fluid transport formations including; massive basalt, clinker zones, and vesicular basalt.

Section 4 – Scope of Work

Specific Comments

Section 4.1, Task 1: Evaluate Subsurface Geology, Page 4-1

Comment 32

Lines 39-40

- This sentence states that NAPL was released to the subsurface under the Red Hill Tanks. There is no firm basis for this conclusion at this time. As stated in our comment #27 above, the Navy needs to consider at least two potential pathways for NAPL to enter the subsurface, a release from Tank 5 that moves laterally out to the rock formations, and a release from Tank 5 that moves down within the concrete cocoon and ultimately to the geology underlying the Facility tanks. Additionally, although NAPL was not directly observed, NAPL can be inferred based on concentrations found in groundwater vs. the aqueous phase solubility of the fuel mixture.

Commented [WR1]: This comment likely should be removed. The first sentence is incorrect as the under-tank borings did show that NAPL had released to the sub-surface. The remainder of the comment is stated elsewhere.

Page 4-2

Comment 33

Lines 12-13

- As part of the data and literature search, the SOW shall include the use of the tank barrel logs.

Comment 34

Lines 27-28

- The effort should not only focus on vertical components of flow but should consider all components of flow direction within the vadose zone and characterize the mechanisms influencing this flow.

Section 4.2 Task 2: Investigate Light Non-Aqueous-Phase Liquid (LNAPL), Page 4-2

Comment 35

Lines 31-41

- The only approach proposed for investigating any ~~L~~NAPL and the risk posed to groundwater and drinking water is an electrical resistivity survey in the lower tunnel. The likely interference from reinforcement metals in the floor of the tunnel and of the similar resistivity characteristics of air and ~~L~~NAPL could significantly reduce the likelihood of gaining useable data. However, given that there is an eight year history of soil vapor readings, and a longer history of groundwater level and contamination data, the Navy should correlate these data sets with other environmental data sets such as precipitation. This may yield much valuable data about ~~LANPL~~ NAPL and other contamination in the vadose zone.

Comment 36

Section 4.3 – Task 3: Identify Chemicals of Potential Concern, Page 4-5

Lines 5-10

- This work plan seems to categorically exclude the possibility that the TPH detected in OWDFMW1 originated from Red Hill UST releases. It must be noted that:
    - OWDFMW1 is part of the NAVFAC agreed upon GWPP monitoring network for evaluating groundwater contamination from the USTs. The source of TPH at this well is not known and the flow paths beneath the facility are poorly understood.

No definitive conclusions can be made as to the source of the elevated TPH at OWDFMW1, so releases from the USTs remain a possibility.

- Figure 3-7 of the EarthTech (2000) report shows groundwater from beneath the Oily Waste Disposal Basin (OWDB) flowing in a direction roughly toward well 2254-01. The groundwater flow direction in this figure is also consistent with recently acquired groundwater chemistry (i.e. chloride data from RHMW06 and RHMW07). Whatever the source of the recurring TPH spikes at OWDFMW1, chemistry at this well should be viewed as indicating what may be captured by drinking water well 2254-01.
- If it is the desire of the Navy to remove OWDFMW1 from consideration in the Red Hill risk assessment, then an approach is required to answer critical questions on the source and nature of the TPH at this well and groundwater flow patterns beneath the OWDB relative to well 2254-01.

Comment 37

Section 4.4, Page 4-5, lines 32-33

- The SOW should ~~to~~ define the process for identifying data gaps, and should establish data qualify objectives for the monitoring network.

Comment 37b

Section 4.5, Task 5: Update the Existing Groundwater Model, Page 4-9

Lines 14-36

- See comments for Appendix H
- SOW needs to identify all potential data sources for model, compare to what was used on previous model, assure the model utilizes all available data, resurvey well elevations, evaluate past modeling efforts based on data, and then come up with an approach using new data to refine model and evaluate model sensitivity. The SOW appears to indicate that only minor updates to the model will be made rather than a thorough revisit of past modeling efforts.

Comment 38a

Page 5-1, line 9

- The term "government" should not be used. All parties to the AOC along with the external subject matter experts are part of government.

Comment 38b

Page 5-2

- Revise this section of SOW to include detailed description of report content and schedule. Outline of reports with minimum content, tables, graphs and figures should be included. Additionally, data management should be discussed. The regulatory agencies would like to get all environmental data in either spreadsheet or database format along with hardcopy and PDF reports.

Page 5-8

- The SOW needs to better describe the process for optimizing the design of data collection. Much the other discussion in section 5.4 is too generic. The SOW should be more specific on how these concepts will be applied at Red Hill.

- The conceptual model should address the flow variation between wet and dry season.

Comment 38c

Section 5.5 Conceptual Site Model

Page 5-9, Figure 12, Preliminary Conceptual Site Model

- The preliminary CSM should highlight the site and study area boundaries. It should also depict, to the extent that information is available, the two main potential contaminant pathways (a release that flows vertically from the tank down to the saturated zone and a release from the sides of the tank that flows laterally from the tanks into the formation. The preliminary CSM should also depict the bedding geology in the study area.
- The conceptual site model should address attenuation. The SOW should describe the approach proposed for assessing attenuation rates.

Comment 39

Section 5.5.2 – Tier III Human Health Risk Assessment, Page 5-11

- Section 8 of the AOC requires a Risk and Vulnerability Assessment. The Navy and DLA should consider eliminating the form 6 and 7 and focusing the Risk assessment effort in Section 8.
- This SOW should include revision of the Groundwater Protection Plan based on the work in the AOC. A revised Groundwater Protection Plan should be a section 6 deliverable.

Lines 15-30

- Although the regulatory documents for a Tier III Health Risk Assessment are referenced, no approach is given as how this evaluation will be done. It is well established that conservative HDOH EALs are exceeded routinely at the site, necessitating the need for a more detailed Tier III risk assessment.
- To be protective of groundwater, an important specific limit that should be evaluated are the soil vapor action limits. A confirmed release occurred at Tank 5 resulting in

significantly elevated soil vapor readings beneath the UST. However, the current soil vapor SSRBLs (site-specific risk based levels) were not exceeded until months after the release. An analysis of the historical soil vapor data should be done to establish the normal range, then a more protective action level established. Specific actions to be followed for exceedances should be included in the updated GWPP.

Comment 40

Section 6.1 Sampling Process Design, Page 6-1

- While the Regulatory Agencies acknowledge that the majority of samples collected as part of this scope of work will be groundwater samples, information on the sample process design for fine grain sediments should be included. This information was included in and can be copied from the recently approved Monitoring Well Installation Work Plan.

Comment 41

Section 6.2.1 – Groundwater Sampling, Page 6-3

Lines 20-22

- OWDFMW1 currently lacks a downhole pump. This should ~~also~~ be noted and information provided on how this critical well will be sampled.

Comment 42

Section 6.2.2 – Topographic Surveying, Page 6-4

Lines 4-12

- The surveying procedures in these sections are suitable for the majority of the environmental investigation sites managed by the Navy. However, in the case of Red Hill the Navy has chosen to characterize the groundwater gradient over an area extending from the Moanalua Ridge to west of the North Halawa Valley as the approach to evaluate possible migration paths of contamination. This is a regional groundwater problem that spans two aquifer systems. This requires that the water level elevations relative to those at the Facility be measured accurately over distances of miles.

  This is a difficult undertaking. Lack of precise Top of Casing Elevations (TOC) of the wells has been a problem with Red Hill investigations from the beginning. Two efforts have been made to resolve this issue, TEC in 2009 and USGS in 2015. Both of these efforts relied on GPS that has vertical accuracies in the tenths of feet. Again, we recognize doing accurate TOC elevations over an area this large is a challenging effort.

We recommend a two-step process:

1) A sensitivity analysis to determine an acceptable level of accuracy that will be required to adequately characterize the groundwater flow gradient.

2) Consult with the NOAA National Geodetic Survey to develop a survey plan that can attain the needed level of accuracy. The contact information is given below.

Edward E. Carlson
National Geodetic Survey
808-532-3205
[HYPERLINK "mailto:ed.carlson@noaa.gov"]

Comment 43

Section 6.2.3 – Synoptic Water Level Reading, Page 6-3

Lines 14-31

- A week long monitoring of groundwater elevations at multiple locations will give a good time-averaged snap shot of relative water level elevations. However, the Navy is proposing to answer critical but currently unanswered questions using water level measurements and groundwater modeling. Key to current investigation is to characterize the response of monitoring locations to pumping stresses. The two previous aquifer response tests lasted for about a month. A review of both tests show that the aquifer water levels may not have recovered completely to pre-test conditions. Currently the response of Red Hill area wells to pumping stresses at the Halawa Shaft may not have been adequately answered during the 2015 USGS/BWS aquifer tests due to interfering pumping at well 2254-01. We recommend that data loggers be retained in critical wells after the week long status-quo water level monitoring period and a series of coordinated (between HBWS and Navy PWS) aquifer tests be done to definitively measure the hydraulic connection between the Red Hill area and the Halawa municipal well source area.

Comment 44

Section 6.2.4 – Proposed Electrical Resistivity Survey, Page 6-4 & 6-5

Lines 32-41 and Lines 1-10

- The Navy needs to further evaluate the practical limitations of the site (e.g. locations of pipelines, presence of rebar in the concrete of the tunnel) to define the study design to ensure that interpretable and usable data are recovered. Assuming the presence of steel rebar embedded in the lower tunnel floor, it is likely the steel will interfere with the readings obtained, leading to inconclusive results.

- The Navy should consider a resistivity transect at the lower to the northwest edge of the Facility in the vicinity of OWDF-MW1, RHMW07, and RHMW06 to see if they can image the high chloride shallow groundwater present in these wells. This could be helpful in evaluating groundwater flow paths within the facility.

Comment 45

Section 6.3, Field and Analytical Sampling Program, Page 6-6

Table 9

- Alkalinity should be added to the list since it also is a chemical indicator of natural attenuation. Also, the Navy has indicated verbally that a suite of major ion samples will be collected. There is no indication of this in the Sampling Program. The regulatory agencies would strongly encourage a round of major ion and dissolved silica analysis to characterize the groundwater chemistry of the study area. Analysis of geochemical data collected by this study, other Red Hill investigations and by University of Hawaii research can be very helpful to understanding the hydrogeology of study area.

Comment 46

Section 7.1.2.2, Matrix Interference, Page 7-1

Lines 30-40

- We would like the Navy to better define the term "biogenic hydrocarbons" since it seems that this term is also used to propose that elevated hydrocarbon detections are not related to fuels stored at the Red Hill USTs.

Appendix H – Work Plan / Scope of Work, Groundwater Flow and Contaminant Fate and Transport Modeling

Comment 47a – Recommended Characteristics of a Red Hill Groundwater Modeling Team

Utilizing a team approach involving highly skilled and experienced members will be critical to the success of the Red Hill modeling effort. The work and products related to this modeling effort will likely be scrutinized in detail by AOC stakeholders, technical experts and the public. In order to achieve the AOC goals, the model related deliverables will need to be able to stand up to this scrutiny and be able to adequately communicate the groundwater flow and fate and transport conditions to the expected diverse audience.

The groundwater and flow and transport models are the data and visualization product upon which risk based decisions will be made. The Moanalua/Red Hill/Halawa area provides approximately 25 percent of the drinking water for urban Honolulu. This area is also the site of a massive fuel storage facility separated from the groundwater by ~~100 to 200~~a little more than 100 feet of fractured rock. It is critical that water resource planners, environmental regulators and managers, and water utility owners and operators have an adequate groundwater characterization to develop proper response measures should a catastrophic release occur. The team doing the groundwater study and associated modeling needs to understand Hawaii hydrogeology, the fate transport processes of fuel transport in all of the phases (i.e. free product, vapor, LNAPL and dissolved), and more importantly the limitations of modeling. Since it is likely that the Red Hill AOC process will be litigated the need for a very defensible groundwater risk study needs to be done by a team that has credibility with the stakeholders and public. Below are listed the desired qualifications for a groundwater risk assessment/modeling team (The Team).

1. The Team must have credibility with the primary stakeholders and the public. The primary stakeholders include:

a. The Navy,

b. The Hawaii Dept. of Health,

c. The U.S. Environmental Protection Agency,

d. The Dept. of Land and Natural Resources,

e. The Army, and

f. The Honolulu Board of Water Supply.

2. The Team must have a superior understanding of Hawaii groundwater flow dynamics and hydrogeology supported by a history of previously successful investigations. The scale of the groundwater risk assessment/modeling problem is regional rather than confined to a specific site. The primary regional problem deals with the degree of water exchange between adjacent aquifers. More specifically, does groundwater that is potentially impacted by a release from the Red Hill USTs remain in the Moanalua Aquifer only impacting the Red Hill Shaft; or is there a flow component toward the Waimalu Aquifer where major municipal pumping centers are located?

3. The Team should have a track record of developing Hawaii groundwater resource assessment models on a regional scale. The groundwater flow, and fate and transport model should not be the primary means of investigation but is rather one of the end products. A model is only as good as the data and skill that goes into the development. However, the model is the product that allows visualization of the results of the groundwater investigation and is the tool for risk mitigation planning. Thus the model becomes the most important product of the investigation. For the model to have credibility The Team must have a proven track record in groundwater resource and risk assessment modeling.

4. The Team should be able call upon assets with demonstrated expertise in other disciplines such as geophysics, geochemistry, and structural geology. If there is a significant groundwater flow component from the Moanalua Aquifer to the Waimalu Aquifer it is due to unidentified subsurface structures. The Team needs to be able to evaluate whether or not it is likely that these structures exist. If the investigation concludes a high likelihood that these structures exist, The Team should be capable of developing a plan to investigate the distribution and geometry of these structures.

5. The Team should have demonstrated expertise in multiphase fate and transport assessments. The drinking water risk assessment must include an assessment of fugitive fuel in its various phases that include free petroleum product in the vadose zone, vapor phase, light non-aqueous phase liquid (LNAPL) phase on the water table, and dissolved phase in the groundwater. The Team needs to have capability or be able to call upon assets to characterize a fuel release from the time it leaves the concrete cocoon surrounding the steel tanks until the dissolved and LNAPL plumes reach steady state, effectively becoming immobile.

Comment 47

Section 1 – Background, Page H-1

Line 38

- The Tripler Army Medical Center drinking water supply wells are located in close proximity to the HBWS Moanalua Wells and should be included in the description of potentially affected wells.

Comment 48

Section 2. Objectives of the Planned Groundwater Modeling, Page H-2

Lines 35-36

- The modeling objectives (and the groundwater study in general) fail to address the primary risk driver. This is the migration of LNAPL due to a large release. As estimated by the 2007 F&T modeling, contaminant concentrations could degrade to less than environmental action levels about 1,200 ft downgradient from an LNAPL source. However, during a large release, the LNAPL would form a relatively thin layer on the water table that could extend significant distances. The important risk driver is not the dissolved plume alone, but rather the combined fate and transport of the LNAPL and dissolved plume. Characterizing the direction and the distance an LNAPL plume will migrate from a large release needs to be critically evaluated.

Comment 49

Section 3.1 – Conceptual Site Model, Page: H-7

- The SOW should describe the process for analyzing the adequacy of previous groundwater studies.

Lines 12-17

- As in previous sections, the SOW/WP refers to a probability of dikes being present. If it is believed dikes are present, this will greatly complicate the groundwater modeling and some approach should be articulated to deal with this difficulty.

Comment 50

Lines 31-34

- The Underground Injection Control (UIC) line is a State of Hawaii boundary between what is considered a drinking water aquifer and a non-drinking water aquifer. The EPA does not recognize this line and considers water makai of the UIC line also a potential source of drinking water.

Comment 51

Lines 36-41

- The description Navy Supply Well 2254-01 also pre-supposes a mauka to makai groundwater gradient. Determining the groundwater gradient is one of the tasks of the groundwater investigation, thus it is inappropriate to make statements such as this: "The infiltration gallery is located hydraulically downgradient from the USTs and intercepts most of the water that would be affected by releases from RHSF."
- Statement: "This well operates at variable flow rates, extracting between 4 and 18 mgd of groundwater from the basal aquifer." Please state the average mgd or range of mgd that pump station 2254 has produced from January 2014 to present if different than 4 to 18 mgd.

Comment 52

Section 3.2 Groundwater Monitoring, Water Levels, and Hydraulic Gradients, Page H-8

Lines 21-22

- The contention that transport of LNAPL to the valley streams could not occur is incorrect. Much of the tank profiles extend above the elevation of the streams (See SOW/WP Figure 7). Due to fractures and in the concrete cocoon, angle iron brackets around the tanks, etc. it is not inconceivable that the fuel could enter the rock formation at an elevation above the bottoms of the tanks and above the stream bed.

Comment 53

Lines 27-34

- Statement: "No dissolved petroleum constituent concentrations, however, have been detected at concentrations approaching the solubility limit of JP-5 suggesting that LNAPL is not present on the groundwater surface." This statement is misleading.

  TPH-d has been detected at concentrations greater than 5 mg/L on numerous occasions at RHMW02. The EPA considers dissolved concentrations equal to or greater than 1% of the solubility limit of a DNAPL as an indication that NAPL is present near the monitoring point (EPA, 2009). Although petroleum free product has not been detected at the groundwater interface, the principle stated in EPA (2009) is applicable and indicates that free phase petroleum may be present near the groundwater interface. The 1% limit (45 μg/L) has been exceeded at RHMW02 for the history of monitoring at this well and routinely at other wells. Also, the contention that low TPH concentrations at RHMW01 suggest that dissolved petroleum compounds are not migrating off site at levels of concern is equally unsupportable since there is no measureable hydraulic gradient between RHMW02 and RHMW01 based on the monthly water level measurements.

Comment 54

Section 3.2 Groundwater Monitoring, Water Levels, and Hydraulic Gradients, Page H-11

Lines 6-7

- See previous comments on this issue. But basically, these numbers indicate a stronger gradient to the NW than to the SW.

Comment 55

Section 3.3.1 Basal Aquifer, Page H-12

Lines 1-15

- Under the heading of "Basal aquifers", the SOW/WP discusses volcanic dikes and dike complexes. Basal aquifers, particularly in the study area, are generally considered to be dike free so the discussion of dikes is not appropriate in this section. A section titled "High Level Groundwater" should be added to discuss dikes and their hydrogeology.

Comment 56

Lines 39-43

- The hydraulic conductivity value the SOW/WP cites as being used by Oki is the transverse not longitudinal value. Oki used 4,500 ft/d for the longitudinal hydraulic conductivity. Also, the referenced to ratio of vertical to horizontal hydraulic conductivity is out dated. Currently the USGS uses 1:100 or 1:200 or more in their models. See Oki (2005), or Gingerich (2012) for examples.

Comment 57

Section 3.4 Previous Numerical Groundwater Flow Modeling, Page H-13

Lines 15-17

- The contention that the longitudinal hydraulic conductivity used in the Rotzoll and El-Kadi (2007) calibrated flow model was substantially higher than other relevant groundwater studies in incorrect. The Kh values are nearly identical to those used by Oki (2005) for a model that included the same area.

Comment 58

Lines 21-27

- Groundwater flow patterns and well zones of contribution modeled by Rotzoll and El-Kadi (2007) cannot be used to assess contamination risk to well 2254-01 or to the Halawa Shaft as this model was not adequately calibrated due to TOC elevation survey issues. Also, there was only a single calibration point used in the Red Hill Ridge so local groundwater flow paths were not properly tested. This is not an indictment of the modelers but indicates that new data has come to light that brings the results of the past model into question. It is also important to note that groundwater flow patterns modeled by Rotzoll and El-Kadi were generally accepted as being correct at the time and accepted by the HBWS. See Hunt (1996) and Todd Engineers and ETIC Engineering (2005).

Comment 59

- The reference to Figure H-3 is not valid to assess the impact of valley fills on contaminant migration since the cross-section shown is well downslope from the USTs and the Halawa Shaft. This figure is also conceptually incorrect in that it shows a depressed water table in the valley fill. A mounded water table would actually be expected due to the low permeability of the alluvium and the increased infiltration from the stream bed.

Comment 60

Lines 36-38

- As with the flow model, the Fate and Transport Model was essentially uncalibrated since there was no field data to compare modeled degradation rates with. Drawing conclusions about degradation rates must be done with caution. As stated in Section 4.5.2, page 4-11, third paragraph F&T model report, the much lower RT3D BTEX package default degradation rates produced a much closer agreement with degradation rates compiled from 39 Air Force remediation sites. An important implication of a slower degradation rate is that the contamination will travel further prior to degrading below action levels. Developing a robust method to estimate a representative degradation rate is an important component of the groundwater risk assessment.

Comment 61

Section 3.5 Evaluation of Fuel Sources, Page H-14

Lines 24-25

- The SOW/WP cites Potter and Simmons (1998) as providing the water solubility limit of Benzene in JP-5 fuel. The maximum solubility of 0.75 mg/L was actually calculated as part of the 2007 F&T modeling effort. No JP-5 chemical analysis could be found that gave a weight percentage for Benzene. A worst case was assumed based on the ASTDR Toxicological Profile for JP-A, JP-5, and JP-8. JP-A has a maximum Benzene concentration of 0.02 weight percent.

Comment 62

Section 3.6, Previous Reactive Transport Simulations, Page H-14

Lines 31-39

- This particular paragraph cites the transport model conclusion that well 2254-01 is the only drinking water source that would be impacted by contamination from the Facility. However, since the underlying flow model was not properly calibrated and the F&T degradation rates were not validated, the modeling conclusions must be used with caution.

Comment 63

Section 3-6, Previous Reactive Transport Simulations, ~~Pahe~~ Page H-18

Lines 21-24

- This comment is for clarification. The SOW/WP correctly cites that early detections of a thin free product layer were followed by a long history of no detections. The absence of any product detection at the monitoring wells after January 2008 is an artifact of redefining what constituted a product detection. Prior to January 2008, any product tone from the oil/water interface detector constituted a detection. However, since many of the detections seemed spurious as indicated by the detection only on the initial meeting of the probe with water surface and were not repeatable, the definition of a detection was changed to that of requiring a confirmation detection by re-lowering the probe to the water table surface.

Comment 64

Lines 25-32

- This paragraph states that JP-5 was released in January 2014. Actually it was JP-8. However, chemical properties are similar.

Comment 65

Lines 36-40

- The statement "..the few groundwater samples in which BTEX compounds have been detected…" is misleading since detections of ethylbenzene and xylenes occur frequently at RHMW02. Although the concentrations, as stated in the SOW/WP, are below DOH HEER EALs, these compounds were detected.

Comment 66

Section 4.1, Model Selection, Page H-19

Line 12

- The SOW should describe the process for reviewing and revising model parameters.

Line 25

- The stated model assumption that all simulated wells fully penetrate the aquifer is incorrect and needs to be changed.

Comment 67

Lines 33-39

- It is important to note that while the model did replicate the relative drawdowns due to changes in pumping stress, there were significant absolute errors. It is also incorrect to state that the agreement between modeled and simulated drawdowns confirms that the Porous Equivalent Medium assumption is valid. Voss (2011) states that the accuracy of a model calibration should be view with some caution and other aspects of the modeling effort given more weight. Numerical model solutions are non-unique in that the same result can be obtained from different input parameter values and distributions. Meaning that a model that calibrates well does not guarantee that correct parameter values and distributions were used.

Comment 68

Section 4.2, Model Domain, Layers, Grid, and Boundary Conditions, Page H-21

Lines 4-19

- A better discussion/justification of boundaries is needed. This discussion should include the type of boundary condition (e.g. no flow, specified head, specified flux, etc.) and justification of the selected boundary condition. Since the Rotzoll and El-Kadi model results were released new groundwater data has come to light showing the potential for inter-aquifer flow, which necessitates closer evaluations of the model boundaries. This is also a recommendation from the USGS.

Comment 69

Section 4.4, Calibration, Page H-21, 22

General Comment

- The USGS aquifer test conducted in 2015 has shown that there are anomalously high water levels within the Red Hill Ridge area. The test further showed the wells with the high water levels responded to pumping stresses, likely those generated at the Halawa Shaft. It is desirable for the modeling work plan to describe how these data will be used in the modeling and calibration process since these anomalies could indicate important heterogeneities in the subsurface.

Comment 70

Section 4.4, Calibration, Page H-22

Lines 12-14

- Estimating recharge is a very involved process. Suggest using recharge values already calculated by the USGS (Engott, et al, 2015 and Izuka et al., 2016).

Comment 71

Lines 15-22

- Porosity is an important parameter for contaminant transport. Porosity should be included in the list of parameters to be varied when calibrating the transient model. Also, there is a reference in these lines to acquiring pumping test data from the USGS. The USGS data are available on-line so there should be no difficulty in obtaining this information. However, the USGS data should be supplemented with pumpage and water level data from the HBWS.

Comment 72

Lines 31-32

- The 15 percent RMSE calibration criteria needs more justification. Cite modeling standards etc. that list acceptable model accuracy standards.

Comment 73

Section 4.5, Predictive Flow Modeling, Page H-31

Lines 37-39

- The SOW needs to define the process for determining the appropriate range of alternative simulations needed and the respective approach to sensitivity analysis for each alternative simulation.
- All but the base case scenario seem to be very vague. At this point in the planning process this may not be unreasonable. However, the input on the future scenarios needs to extended beyond the AOC parties to the HBWS and CWRM since they are stakeholders in this process. The distribution of pumping and the location of a hypothetical new well in the future scenarios will greatly influence the model results. Thus it is important to get input from the stakeholders that will likely initiate any changes in groundwater withdrawals. One scenario that should be run is a drought scenario using the USGS drought period recharge coverage for Oahu (Engott et al., 2015).
- Also, as suggested by the USGS, ~~the change in boundary conditions resulting from~~ modifying the model from the base scenario will require that the boundary conditions ~~needs to~~ be carefully evaluated and appropriate ~~new boundary conditions incorporated~~modifications may be necessary.

Comment 74

Section 5, Technical Approach for Refining the Contaminant Fate and Transport Model, Page H-33

Line 2

- It is important to note that production of CO_2 due to natural attenuation of hydrocarbons increases the alkalinity of the water. Alkalinity should be included in the NAPs analysis list.

- General Note: Both the groundwater flow, and fate and transport model technical approaches uses the word "Refine". This implies minor revisions. It should be considered that major changes may be necessary to adequately assess the risk to groundwater and drinking water posed by the Facility ~~may be major~~.

Comment 75

Section 5.1, Objections, Page H-33

Lines 18-29

- The AOC – SOW **Section 7.2, Contaminant Fate and Transport Model Report**, states that "The purpose of the Contaminant Fate and Transport Model Report is to utilize the Groundwater Flow Model to improve the understanding of the potential fate and transport, degradation, and transformation of contaminants that have been and could be released from the Facility".

  It should be explicitly stated as a modeling goal that the fate and transport of a major release be rigorously characterized. To accomplish this, a large release needs to be characterized from the time it leaves the concrete cocoon, until the plume becomes immobile (i.e. LNAPL transport) and the dissolved plume reaches steady state (i.e. through degradation, transformation, and dilution).

Comment 76

Section 5.2, Model Selection, Page H-34

Lines 1-3

- This is inaccurate to state that there was an attempt to match modeled NAP reaction rates to measured data. There was insufficient data to attempt to develop site specific reaction rates. Reaction rates were tested during sensitivity analysis and it was determined that reaction rates borrowed from the Hill AFB site may have been too optimistic. We concur with the uncertainties regarding the modeled RT3D degradation rates. However, these uncertainties exist even if MT3D is used.

Comment 77

Section 5.2, Model Selection, Page H-35

Lines 1-16

- It is unclear in the SOW/WP how a first-order degradation rate will be selected, and more importantly, validated. Typically, this requires having concentrations at two or more locations along a groundwater flow path and knowing the velocity along that flow path. The SOW/WP needs to document how these two parameters (i.e. flow path and transport velocity) will be quantified with confidence and how the results will be used to develop defensible first order degradation rates.

- This comment is provided for informational purposes to assist with the work plan development. There are serious plumbness issues with TAMC MW2. Being a two inch well with long depth to groundwater, its casing snakes around severely biasing water levels measured at this well. Also, it unlikely that a True Vertical Depth survey can be done on this well due to the kinks in the casing.

Comment 78

Section 5.2, Model Selection, Page H-35

Lines 20-21

It is difficult to see how decay rates can be estimated using time series data. The first order decay equation that is likely to be used does not account for advective transport of contamination away from the source area or sorption within the source area. There are too many undefined variables to do the decay constant calculation with confidence. Some method needs to be articulated to replace some of the unknown variables with measured parameters. The most straightforward way to do this is with a well-designed and executed tracer test where the critical transport parameters can be measured.

Comment 79

Section 5.3, Model Setup, Page H-35

Lines 22-39

- Although the header says "Model Setup" the text only justifies using MT3D versus RT3D. There is nothing else in this section that deals with model setup other than stating it will use the same grid as the MODFLOW model. Since MT3D requires the MODFLOW solution to simulate transport there is no flexibility in using any other grid.

Comment 80

Section 5.5 Model Parameters, Page H-36

Lines 10-13

- The SOW/WP incorrectly states that the longitudinal dispersivity used in the 2007 F&T model was 20 meters. The actual value was 112 feet (34 m). It is likely that the 20 m value stated came from the Lahaina tracer test report. This needs to be clarified and corrected. Also, the porosity value of 0.05 for the 2007 F&T model was chosen to be consistent with SWAP modeling. Inverse modeling during the flow simulations estimated a porosity of 0.031. If the inverse modeling porosity were used in the transport model, the contaminant migration velocity would increase by a factor of 1.6. This does need to be considered when developing the model and interpreting the results.

- The SOW should define a process for evaluating the sensitivity of the transport parameters.

Comment 81

Section 5.5.4, Dispersivity, Page H-38

Lines 3-5

- The dispersivity value stated in this section differs from that in Table 2. Of greater consequence (as this section points out) is the broad range of literature dispersivity values. The parameter can be directly estimated from a well-designed and executed tracer test.

Lines 17-18

- The rate of degradation for future releases cannot rely solely on site-specific concentration data. Varying degrees of mass release would likely influence degradation rate. The SOW should define a robust process for evaluating the range of potential degradation rates likely to occur for various release scenarios at Red Hill.

Comment 82

Section 5.5.5, Degradation, Page H-38

Lines 7-21

- Multiple processes are working on these concentrations. Each has to be accounted for in some way to estimate a first order decay coefficient. Particularly problematic is the spatial distribution of contaminant concentration. Unless the groundwater flow direction is aligned with the positional track of the monitoring wells and the groundwater flow velocity is known with certainty, then calculating the first order decay coefficient becomes very problematic. Wiedimeier et al., 1996 documents a method to estimate degradation rates by comparing the contaminant concentration trends with that of a tracer. In the case of this investigation, it would likely be necessary to introduce a conservative tracer. So again, a well-designed and executed tracer test can provide valuable data for F&T modeling.

Comment 83

Section 5.6, Calibration, Page H-38

Lines 26-37

- The degree of calibration described does not seem reasonable to obtain. The uncertainties are too great and include; the mixing of recent and legacy contamination, the footprint of the contaminant source area, unknown sorption and degradation coefficients, and the geometry of subsurface structures that are implied by the groundwater level anomalies. An alternative analytical approach may be to produce a set of probability realizations showing likely transport paths and velocities.

Comment 84

Section 5.7 Predictive Transport Simulations, Page H-39

Lines 1-13

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- The SOW/WP only proposes to simulate the dissolved phase transport from an arbitrarily defined stationary LNAPL source. This is a repeat of what was done in 2007. Since it is a repeat it is uncertain why it needs to be done again in a numerical F&T model. There are many other critical F&T processes that need to be evaluated but are not included in the SOW/WP (e.g. vadose zone transport, LNAPL transport on the water table, etc).
- The purpose of the modeling is to define the risk to groundwater and to the area's drinking water resources threatened by the current and any future potential releases.

  When considering a future release, the F&T of a large LNAPL release must be considered. The proposed modeling only evaluates the groundwater flow paths and the F&T of the dissolved plume after the LNAPL becomes immobile. Also, there is insufficient detail in the SOW/WP for the regulatory agencies to evaluate whether or not the dissolve phase F&T portion of the risk assessment will be adequately validated.

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